DUNHAM

SUB-ATMOSPHERIC STEAM

Heating Systems

and

Heating and Air-Conditioning Units

COMFORT CONDITIONING by DUNHAM

C. A. DUNHAM COMPANY CHICAGO

THE DUNHAM *Sub atmospheric* STEAM HEATING SYSTEM

Dunham Sub-Atmospheric Steam Heating is provided by a simple two pipe heating system in which all essential functions of circulation, distribution and control are coordinated to provide economical, satisfactorily balanced heating.

Provides an IMPROVED MEANS for Controlling the Heating of a Building

Reliable temperature control for a heating system involves more than the mere control of the RATE of heat supply. The varying supply of heat must be distributed through the heated space equally, automatically, continuously.

The Dunham Sub-Atmospheric System performs all of these functions quickly and economically. Desirable building temperatures are automatically maintained under varying weather conditions, and at a control station which may be located in the boiler room, remote readings of building temperatures and operating conditions may be taken.

The Control Is Fully Automatic*

The Dunham Sub-Atmospheric System provides the radiators with steam at a temperature and in the amount required to meet heating demands of widely varying weather conditions. Beginning with a heat output obtained by steam circulation at a pressure of 2 pounds and a temperature of 218 degrees F., or more, as required, the output is progressively reduced according to the demands of the weather by a reduction in the rate of steam admission to the system, which automatically causes a reduction in steam pressure and temperature so that steam may be circulated at varying temperatures down to about 133 degrees F.

Further reduction in heat output is obtained by partial filling of radiators with sub-atmospheric steam until the point is reached at which the need for heat ceases and the supply of steam is completely shut off.

A positive continuous circulation is maintained as a fundamental function of the system. This tends to maintain unusually constant temperature levels throughout the building.

You Will Obtain Distinctive Control and Economy Features from the Dunham Sub-Atmospheric System

The vitality, efficiency and health values of controlled heating, while readily demonstrable in tests, are normally regarded as intangibles difficult to evaluate.

The Fuel Saving which results from temperature control is, in contrast a tangible advantage which can be measured in terms of dollars required to buy steam, oil, gas or coal.

*Can also be installed for manual control.

The most conclusive and unassailable evidence, however, is the "before" and "after" data and tenant reaction from buildings heated by ordinary systems and "changed over" to Sub-Atmospheric Heating. In percentages these annual savings run from 25 % to 50 % and in dollars they represent a rather large fraction of the cost of converting the installation.

Economies may be summarized:

1. Control of building temperature extending over the entire heating season with accuracy under mild weather conditions.
2. Control of heat loss from supply piping.
3. No upset of system control by abnormal demands such as opening windows.
4. Normally no injurious corrosion is encountered in low pressure steam heating systems. Where there is such corrosion, Sub-Atmospheric Steam Heating has a distinct value. In Sub-Atmospheric steam the rate of penetration by corrosion in the piping system is reduced approximately 50 % from that obtaining in systems operated at atmospheric pressure. Data on tests conducted at the Michigan College of Mining and Technology will be found in the Proceedings of the A. S. H. V. E.

The Sub-Atmospheric System Is Equally Successful in the Small as Well as Large Commercial Building

The fact that Dunham Sub-Atmospheric Steam Heating is giving satisfying heat comfort today in buildings whose requirements range from the whole group of skyscrapers of Rockefeller Center in New York and of commercial buildings in practically every state of the Union to those of fine large private residences, affords sufficient proof of its complete adaptability to heating requirements.

LET A DUNHAM SALES ENGINEER DISCUSS YOUR PRESENT AND FUTURE PROJECTS WITH YOU

The accumulated experience of the Dunham organization is put at the disposal of the Architect, the Heating and Ventilating Engineer and other officials. This cooperation is available for Modernization Work, as well as for new construction in industrial, commercial, housing and other projects.

Consult your classified telephone directory for address of "Dunham Heating Service" in your city, and discuss your problems with the Dunham Sales Engineer. These specialists are ready to give valuable service in selecting the correct Dunham System and Appliances for any type of building. If there is no Dunham representative in your city, write to the Chicago office for address of your nearest Dunham Sales Engineer.

C. A. DUNHAM COMPANY

Administrative and General Offices, 450 E. Ohio St., Chicago, Ill.

FACTORIES—Marshalltown, Iowa; Michigan City, Indiana.

CANADA—C. A. Dunham Co., Ltd., 1523 Davenport Rd., Toronto, Ontario.

ENGLAND—C. A. Dunham Co., Ltd., Morden Road, London, S. W. 19.

Consult your local classified telephone directory for address of "Dunham Heating Service" in your city.

SALES ENGINEERS' OFFICES

Albany, N. Y.
Allentown, Pa.
Atlanta, Ga.
Baltimore, Md.
Bangor, Maine
Birmingham, Ala.
Boston, Mass
Buffalo, N. Y.
Champaign, Ill.
Chattanooga, Tenn.
Chicago, Ill.
Cincinnati, Ohio
Clarksburg, W. Va.
Cleveland, Ohio
Columbus, Ohio
Dallas, Texas
Davenport, Iowa
Denver, Colo.
Des Moines, Iowa
Detroit, Mich.
Duluth, Minn.
El Paso, Texas
Grand Rapids, Mich.
Greenville, S. C.
Harrisburg, Pa.
Houston, Texas
Huntington, W. Va.
Indianapolis, Ind.
Joliet, Ill.
Kalispell, Mont.
Kansas City, Mo.
Kingston, Pa.
Little Rock, Ark.
Los Angeles, Calif.
Louisville, Ky.
Madison, Wis.
Memphis, Tenn.
Michigan City, Ind.
Milwaukee, Wis.
Minneapolis, Minn.
Missoula, Mont.
Newark, N. J.
New Haven, Conn.
New Orleans, La.
New York, N. Y.
Oklahoma City, Okla.
Omaha, Nebraska
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Oregon
Poughkeepsie, N. Y.
Providence, R. I.
Richmond, Va.
Rochester, N. Y.
St. Louis, Mo.
Salt Lake City, Utah
San Antonio, Texas
San Francisco, Calif.
Seattle, Wash.
Spokane, Wash.
Springfield, Mass.
Syracuse, N. Y.
Tampa, Fla.
Toledo, Ohio
Trenton, N. J.
Washington, D. C.
White Plains, N. Y.
Wichita, Kansas

THE DUNHAM SUB-ATMOSPHERIC HEATING SYSTEM

Principles & Fundamentals

Steam Volume and Temperature Variation resulting from variation of Pressure are the fundamentals of the Sub-Atmospheric System.

Control of the temperature of the steam in the radiators is accomplished by controlling the pressure or vacuum of the steam in the supply piping and radiators. This basic fundamental of the Dunham System is based on the "Properties of Vapors." Refer to your "Steam Table."

Again, the heat output of the radiation is further reduced by the partial filling of radiators with sub-atmospheric steam, the amount of partial filling being reducible to the point at which the need for heat ceases entirely.

These two fundamentals form the basis upon which the system was developed. See illustration below.

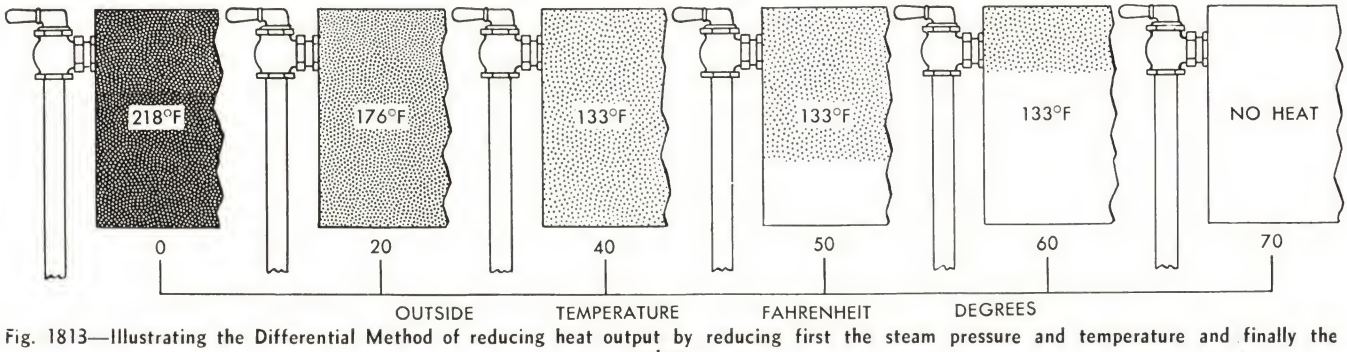


Fig. 1813—Illustrating the Differential Method of reducing heat output by reducing first the steam pressure and temperature and finally the volume.

APPLICATION OF THE ABOVE PRINCIPLES

The application of these principles results in a practical heating method by which building operators maintain a balance between heat losses from buildings and heat supply from the heating system. This is accomplished by delivering steam uninterruptedly to the radiators at pressures and temperatures in varying amounts in response to weather demands.

In order to appraise the full value of Differential Heating, it is necessary to understand both the operation and function of each part of the system and the result of their cooperative action. The simplicity and effectiveness of the Dunham Sub-Atmospheric Heating System is attained through this coordinated action.

The Resistance Thermometer Principle

Resistance thermometers are based on the property of those metallic conductors whose electrical resistance varies with variations in their temperature. They are widely used (in conjunction with a Galvanometer) to measure and to indicate temperatures or temperature changes. They are uniquely sensitive, accurate and long lived, operating *without* moving parts or wear.

Measuring Heat Demand

The demand for heat is measured by the resistance thermometer principle. Variations in temperature at control points create variations in electrical resistance in control circuits. The supply of heat is varied with the demand by using these variations in electrical resistance through Wheatstone Bridge circuits to actuate a Control Valve governing steam supply. The distribution of the steam is automatically maintained under all variations in supply by the coordinated functioning of the Traps, Pump, Differential Controller and Regulating Orifices at radiator inlets.

THE FUNCTION OF THE PARTS

The Control Valve regulates the admission of a continuous flow of steam into the heating main as called for by the room thermostat. Modifications in the rate of heat supply are made in accord with the building heat requirements determined by the thermostat. Where more than one thermostat is used, they are located in relation to the height and exposure of the building or heating zone and are interconnected at the terminal box to enable them to measure the average heat requirements and give average temperature regulation.

The Control Panel is the operating station at which the control settings are made and from which remote readings of room temperatures and control valve openings may be taken. See pages 6 and 7 for detailed description.

Radiator and Drip Traps prevent steam passage while permitting condensate and air to flow to the return piping. Throughout the entire range of pressure and vacuum variation, they release the air and condensate from radiators and steam lines and prevent the escape of steam into the return piping.

To provide the range of vacuums under which this system functions, a Differential Vacuum Pump is provided that is amply capable of producing and maintaining the necessary wide range of vacuums. This pump also operates to handle the condensate from the system. This water gravitates to an accumulator tank from which it is lifted and returned to the boiler by the pump.

Ordinary heating systems have only "Push" to secure circulation. Dunham Sub-Atmospheric Steam Heating has "Push" and "Pull." The controlled steam flow, or "Push" pressure, established in the supply side by the rate of steam admission through the Control Valve, and the "Pull" pressure (vacuum) in the return line both act upon the Differential Controller which starts and stops the vacuum pump to maintain the return pressure continuously lower within fixed limits than the supply pressure under all rates of steam admission to the system.

In brief, the Dunham Sub-Atmospheric Heating System provides for:

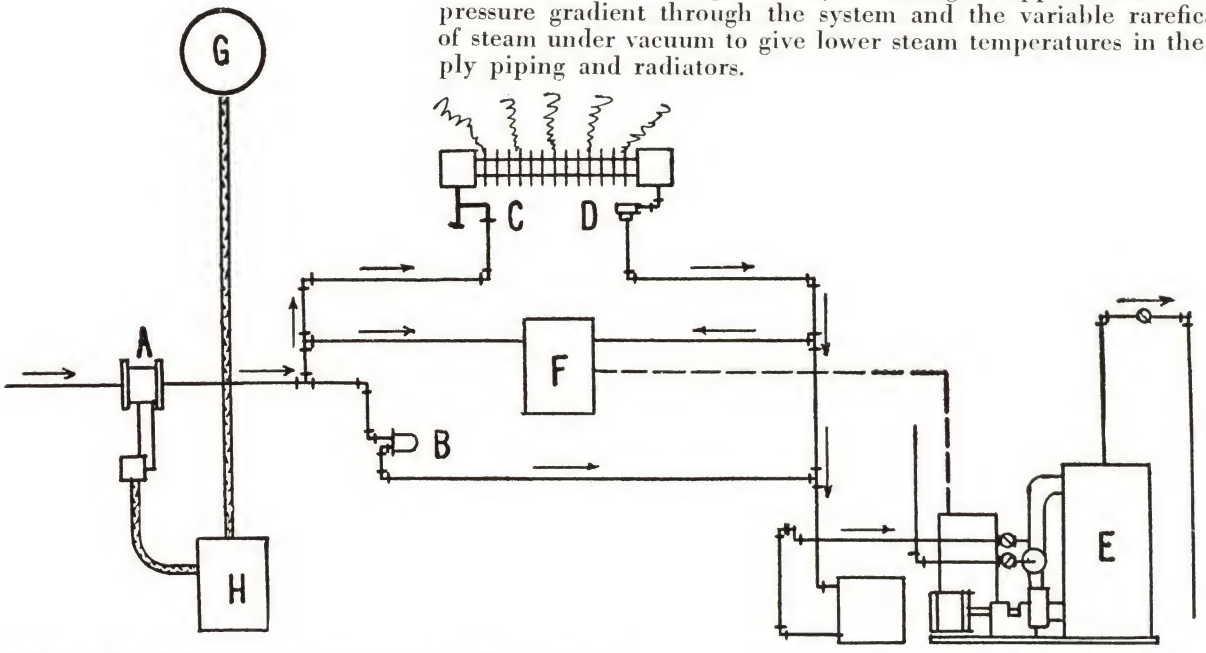
1. The maintenance of positive, continuous steam circulation, with complete venting of air and removal of condensate, and with no short-circuiting of steam from supply to return piping.
2. The proportional distribution of steam to each unit of radiation under all rates of supply.
3. The control of the rate of heat output from system in accord with the variable rate of heat requirement *caused* by outside temperatures, wind, sun, cloudiness and moisture and modified by the heat stored in building (thermal capacity) and rate of heat transfer through the building walls.

THE DUNHAM SUB-ATMOSPHERIC STEAM HEATING SYSTEM

A Coordinated "System" Solution OF THE PROBLEM

OF SATISFACTORY HEATING

This has been accomplished by obtaining an approximate constant pressure gradient through the system and the variable rarefication of steam under vacuum to give lower steam temperatures in the supply piping and radiators.



The cycle of steam flow is shown above and the units are illustrated below.

A—The Control Valve supplies steam continuously. The rate varies but the supply is uninterrupted.

B—Drip Traps keep steam mains and riser free from water and air and return mains free from steam, making circulation rapid and noiseless.

C—Radiator inlet valves with externally adjustable or internally fixed orifices at each radiator inlet give balanced steam distribution throughout the building.

D—Radiator Traps allow air and water to leave radiators and prevent steam from entering the returns under the entire range of sub-atmospheric pressure employed.

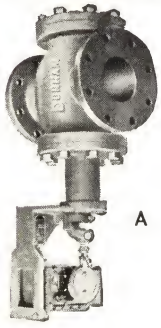
E—The Differential Pump is specially designed to create and maintain steam circulation under sub-atmospheric pressures.

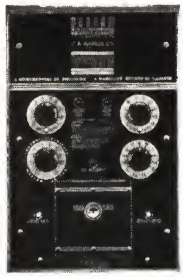
F—The Differential Controller governs Pump operation to maintain return line pressures lower than supply line pressures (by a fixed range) for all rates of steam supply through Control Valve, thus insuring equalized circulation which is positive, continuous and at substantially constant velocity.

G—Resistance Type Temperature Sensitive Equipment evaluates heat demand in the building. This equipment has no moving parts, nothing to wear out, clog or get out of adjustment.

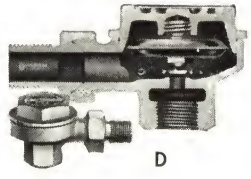
H—The Control Panel governs Control Valve Operation, centralizing all control adjustments and additionally measures and indicates the conditions it governs.

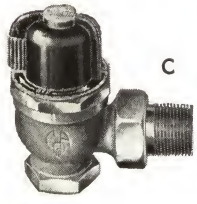
Units of Control

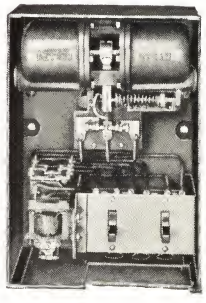

A


H

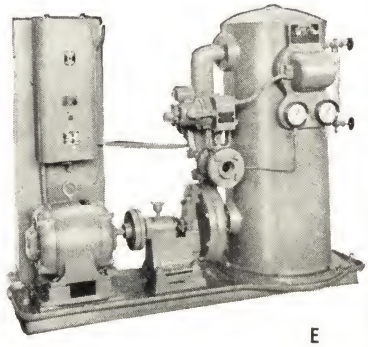

B


D


C


F


G


E

Zone Control

To insure a high degree of precision in temperature regulation and the lowest possible heating costs, it may be advisable to divide larger buildings into a number of heating zones, each having an individual system of supply piping and each being controllable in accordance with the particular heat requirements of the section it serves.

This practice is called zoning. It is used in buildings serving more than one purpose, such as an office building containing stores or a theater; in institutional buildings housing various departments and services with varying temperatures and time requirements for heat; and in tall buildings with sectional variations of wind and sun exposure and subject to the phenomena of "stack (chimney) effect." Obviously each zoning project must be dealt with individually. This should be done in the light of the factors of service requirements, occupancy, exposures (wind and sun) and the construction, size and shape of the building.

When a Sub-Atmospheric installation is zoned, each zone is regarded as an individual system. Each zone requires a separate system of piping. Each also requires a separate Control Valve and the proper regulating equipment. Where the radiation load of two or more zones does not exceed the capacity of a single Differential Pump, one pump may serve a plurality of zones. Where one zone comprises blast radiation, a separate pump is usually required for this load.

Control FOR THE DUNHAM SUB-ATMOSPHERIC HEATING SYSTEM

The RT (Resistance Thermometer) control equipment is available in three models:

(1) The MODEL T CONTROL
(2) The MODEL RS CONTROL
(3) The TRS AND TRST CONTROL

The available models of RT Control (T, RS, TRS, TRST) are made up of three or more of the devices described below. The designs have reduced the problem of control in the Sub-Atmospheric System and have provided greater stability, accuracy and responsiveness. Smoothness of action is provided by the design of the Thermostat, Valve and Panel.

A BRIEF DESCRIPTION OF THE UNITS

The Dunham Control Valve

The advantages of the Control Valve are as follows. The inner valve provides smooth increments of steam flow and prevents sudden surges in this flow. Low voltage reversing motors are used on all sizes and no relay is mounted in the motor housing. The positioning of the Control Valve from the Panel, as required by the thermostatic devices, is accomplished in a unique manner. The valve is a true throttling and proportioning valve, and sudden swings of large magnitude are prohibited by the manner in which it is positioned. After a small change in valve positioning has occurred, the valve is allowed to remain stationary for a short interval before a further change is made. This space of time allows the change to become effective before further positioning is accomplished. Later a further change is made. In other words, the full correction of the Control Valve, as indicated by the thermostatic devices, is not made immediately (which would cause "hunting"). Time intervals are introduced so that the heat output is balanced with the requirements as measured by the thermostatic devices.

The Dunham Thermostat

In the Thermostat there are no moving parts, no contacts to clog, no settings or adjustments, no lost motion, wear or maintenance. These are major improvements from the maintenance viewpoint and for continued satisfactory operation. There is no movement of the thermostatic element, therefore there can be no inertia. Temperature changes immediately affect the Thermostat.

The Thermostat and its mounting plate are adaptable for installing over a standard 2¼x4 in. switch wall box, or directly to the wall with wood screws.

The Dunham Selector

The Selector is a thermostat and is always mounted on the inside surface of a window or transom. It is essentially a resistance thermometer—with no moving parts, contacts, lost motion or wear.

It evaluates heat loss by measuring temperature changes on the inside surface of the pane of glass.

The use of the inner surface of a window rather than the outdoor air has several advantages. A thermostat installed in the outside air is affected by this air temperature only. The temperature on the inner surface of a window is affected by wind velocity and other weather conditions in addition to the temperature of the outside air. This gives a better measure of the heat demand than does the outside temperature only. The Selector also responds to inside conditions, showing lower temperatures when the inside rooms are not up to temperature. This results in an indicated demand greater during the heating up period than after room temperatures have been established.

The Dunham Heat Balancer

The Heat Balancer is also a thermostat and at the same time a control radiator. It functions to insure that the actual heat output of the heating system is in keeping with the demand. It evaluates the heat output by measuring the average rise in temperature of the total air stream passing through a radiator. The steam supply to this radiator is balanced by its regulating fitting to represent the supply to all radiators in the building or zone. The use of resistance thermometers *below* and *above* the convector make possible the measurement of the rise in temperature independent of variations in inlet air temperatures.

The Heat Balancer has no moving parts. It has the same general appearance as an attractive cabinet radiator. The fact that it is complete with its own radiator simplifies the problem of application.

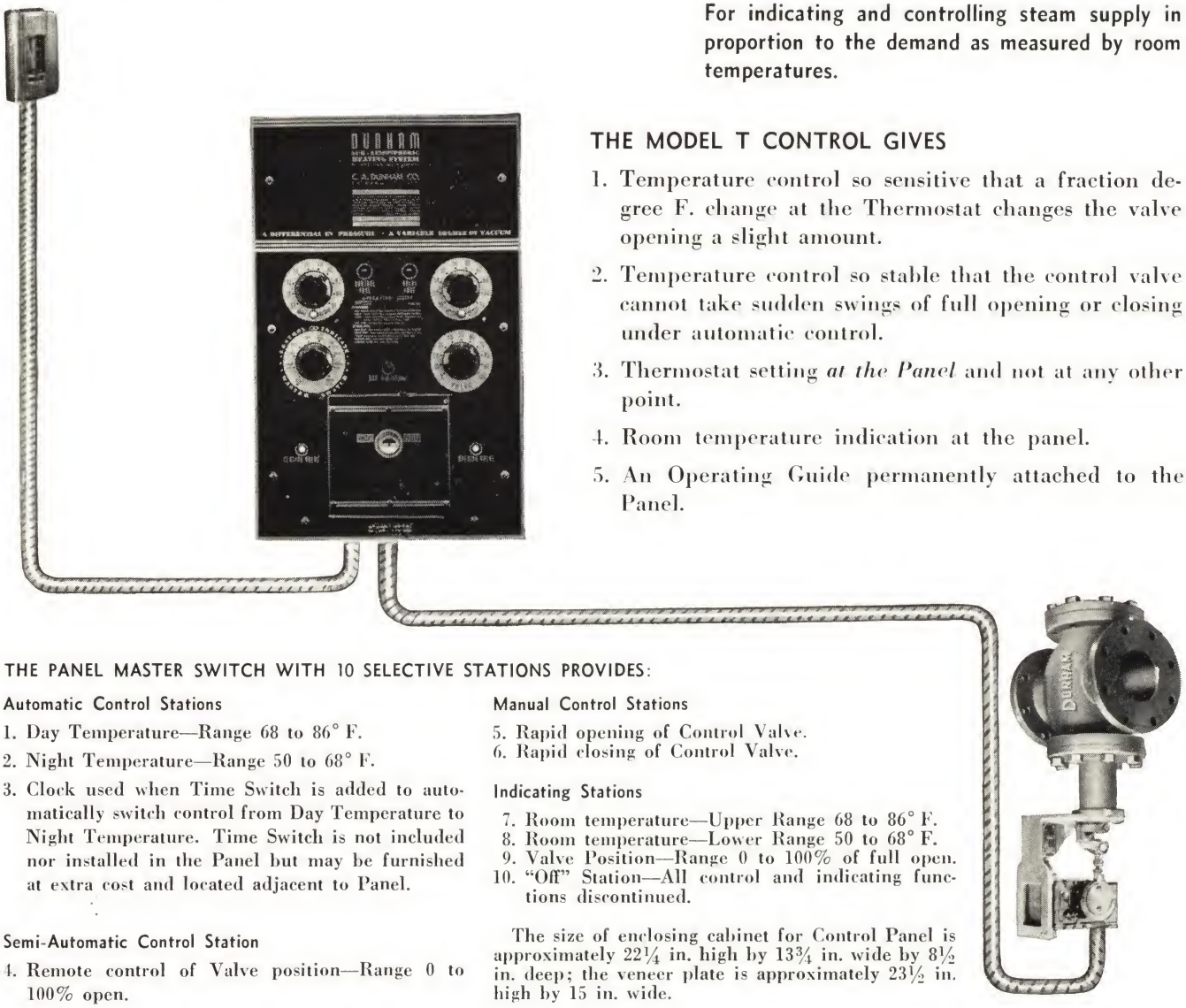
The Dunham Panel

The Panel transmits the changes at the thermostats (the Room Thermostat, the Selector and the Heat Balancer are essentially all a type of thermostat) to the necessary power to position the Control Valve. Here again the effect of inertia is reduced to insignificance. A fraction of a degree change at the thermostat is sufficient to cause the galvanometer relay to function to move the Control Valve a slight amount. The feature which is probably the most attractive to laymen as well as to Architects and Engineers is the fact that the Panel is "alive." It is continually telling a story of what is happening at the different points of the system. Additionally, it has a number of indicating and controlling stations which can be used at the will of the operator to determine room temperatures, valve opening, heat output, etc. The attractive panels have been designed by internationally known industrial designers.

COMBINATIONS OF CONTROL FOR THE DUNHAM SUB-ATMOSPHERIC STEAM HEATING SYSTEM

THE *Model* T Consisting of a Panel, a Control Valve and one or more Thermostats

For indicating and controlling steam supply in proportion to the demand as measured by room temperatures.



THE MODEL T CONTROL GIVES

1. Temperature control so sensitive that a fraction degree F. change at the Thermostat changes the valve opening a slight amount.
2. Temperature control so stable that the control valve cannot take sudden swings of full opening or closing under automatic control.
3. Thermostat setting *at the Panel* and not at any other point.
4. Room temperature indication at the panel.
5. An Operating Guide permanently attached to the Panel.

THE PANEL MASTER SWITCH WITH 10 SELECTIVE STATIONS PROVIDES:

Automatic Control Stations

1. Day Temperature—Range 68 to 86° F.
2. Night Temperature—Range 50 to 68° F.
3. Clock used when Time Switch is added to automatically switch control from Day Temperature to Night Temperature. Time Switch is not included nor installed in the Panel but may be furnished at extra cost and located adjacent to Panel.

Semi-Automatic Control Station

4. Remote control of Valve position—Range 0 to 100% open.

Manual Control Stations

5. Rapid opening of Control Valve.
6. Rapid closing of Control Valve.

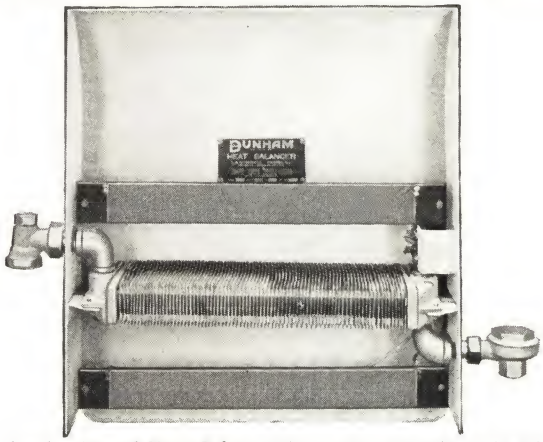
Indicating Stations

7. Room temperature—Upper Range 68 to 86° F.
8. Room temperature—Lower Range 50 to 68° F.
9. Valve Position—Range 0 to 100% of full open.
10. "Off" Station—All control and indicating functions discontinued.

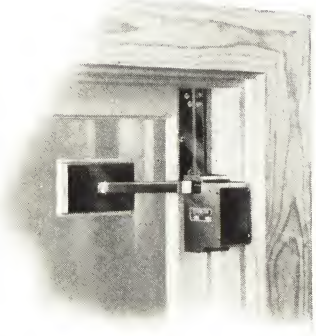
The size of enclosing cabinet for Control Panel is approximately 22¼ in. high by 13¾ in. wide by 8½ in. deep; the veneer plate is approximately 23½ in. high by 15 in. wide.

ILLUSTRATIONS OF CONTROL EQUIPMENT USED WITH PANEL AND CONTROL VALVE

Inside view of Thermostat (no moving parts) used with Models T, TRS, TRST

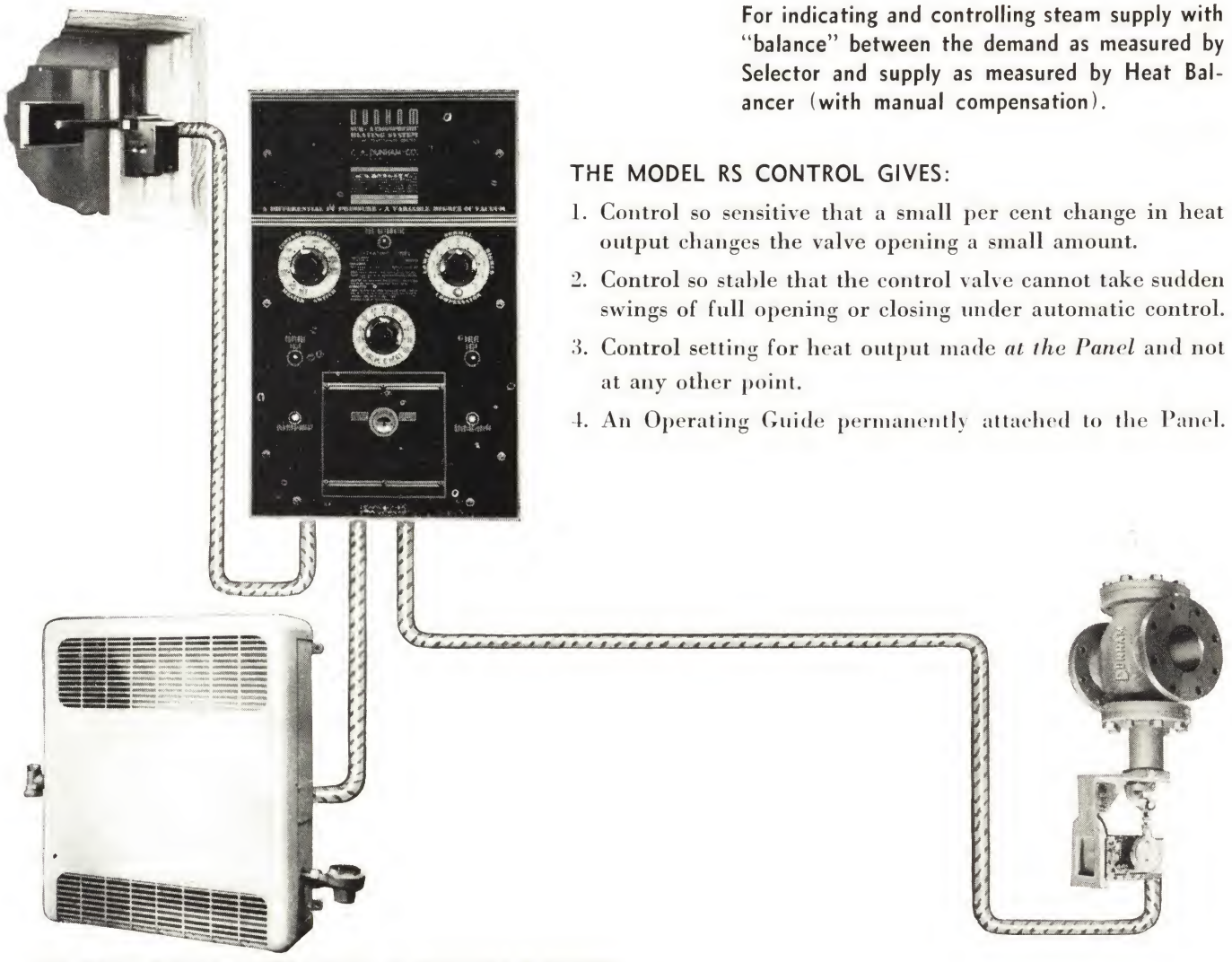


Inside view of Heat Balancer (no moving parts) used with Models RS, TRS and TRST



The Selector (no moving parts within it, but a movable arm to permit opening of window) used with Models RS, TRS and TRST

THE *Model* RS consisting of a Panel, a Control Valve, a Selector and a Heat Balancer.



For indicating and controlling steam supply with "balance" between the demand as measured by Selector and supply as measured by Heat Balancer (with manual compensation).

THE MODEL RS CONTROL GIVES:

1. Control so sensitive that a small per cent change in heat output changes the valve opening a small amount.
2. Control so stable that the control valve cannot take sudden swings of full opening or closing under automatic control.
3. Control setting for heat output made *at the Panel* and not at any other point.
4. An Operating Guide permanently attached to the Panel.

THE PANEL MASTER SWITCH WITH 10 SELECTIVE STATIONS:

Automatic Control Stations

1. Day Control—Normal Heat supply in relation to weather, with manual compensation.
2. Night Control—Reduced heat supply for night operation.
3. Clock used when Time Switch is added to automatically switch control from Day Temperature to Night Temperature. Time Switch is not included nor installed in the Panel but may be furnished at extra cost and located adjacent to Panel.

Semi-Automatic Control Stations

4. Remote Control by Heat Balancer—Range 0 to 100% Heat Output.
5. Remote Control of Control Valve Position—Range 0 to 100% Open.

Manual Control Stations

6. Rapid opening of Control Valve.
7. Rapid closing of Control Valve.

Indicating Stations

8. Heat Output—Range 0 to 100% of maximum.
9. Valve position—Range 0 to 100% of full open.
10. "Off" Station—All control and indicating functions discontinued.

The size of enclosing cabinet for Control Panel is approximately 22¼ in. high by 13¾ in. wide by 8½ in. deep; the veneer plate is approximately 23½ in. high by 15 in. wide.

Models TRS & TRST consisting of a Panel, a Control Valve, a Selector, a Heat Balancer and one or more Thermostats.

For indicating and controlling steam supply in proportion to the demand as measured by room temperatures with maximum and minimum limits established by Heat Balancer and Selector.

Models TRS and TRST are the only controls on the market that provide fully automatic control in response to the effect of outside weather conditions and to building heat-loss.

Added features of TRS and TRST, not obtainable in other models include additional indicating and Controlling Stations; optional Time Switch built into the Panel cabinet; window thermostat; continual checking of actual heat output (by the Heat Balancer) and a means of limiting it to demands of the Selector. Yet, both Selector and Heat Balancer affect the heat supply only when it is not kept within the limits as set by outside weather.

At all times there is an automatic control of the steam supply with a maintained balance between heat supply and demand. At the Panel are 6 pilot lights that continually flash fundamental signals to the operator.

These features insure a most simple, trouble-free operation not previously approached.

A Typical Specification

1. THE GENERAL CONDITIONS governing this work shall be those established as standard by the American Institute of Architects.

2. CONSTRUCTION AND MATERIALS. The heating installation proposed includes the furnishing, delivery and erection of all necessary material, which shall be first class in all particulars and in accordance with the specifications, heating plans and manufacturer's details.

3. INSPECTION. The Contractor shall allow the representative of the manufacturer of the controlled heating system to inspect the installation and shall lend any assistance necessary to expedite and perfect the work.

4. SCOPE OF WORK. The Contractor shall furnish and install a Sub-Atmospheric Steam Heating System in which the distribution and circulation of steam shall be balanced or equalized by means of externally adjustable or internally fired orifices at radiator valves to insure all radiators receiving steam at the same time and in quantities proportional to the size of the radiator, all in accordance with these specifications, the accompanying plans and instructions issued by the manufacturer.

5. PATENTS. The Contractor shall obtain and furnish the owner with a license to install and operate the system specified above under U. S. Letters Patent Nos. 1,644,114; 1,771,077; 1,983,218; 1,802,383 and 1,802,384.

6. BOILER. Steam for the heating system shall be supplied from the boiler plant located as shown on the drawings. The steam boiler shall be a.....with guaranteed rating for at least..... sq. ft. of equivalent direct radiation. It shall be installed upon a suitable foundation in accordance with the boiler manufacturer's instructions. It shall be equipped with all necessary connections and trimmings, including a safety valve set to blow at 10 pounds pressure, a Compound Gauge 15 pounds by 30" vacuum, and a sensitive Damper Regulator and approved boiler feeder or other adequate means to insure proper boiler water line at all times. (Omit Regulator on gas-fired and automatic oil-fired installations.)

7. SMOKE PIPE. Connect boiler to chimney with suitable black iron pipe ..... gauge. Size to be as recommended by Boiler Manufacturer. Smoke pipe must be provided with hand stop damper. (Omit damper on gas and oil-fired installations.)

8. AUTOMATIC CONTROL EQUIPMENT. Steam mains shall be run as indicated on the drawings. The steam main to each zone shall be provided with an electrically operated control valve of the throttling and proportioning type. The control valve shall function as an integral part of a heating system capable of circulating steam at variable sub-atmospheric pressures and temperatures and simultaneously providing continuous steam flow to the system. Control valves shall be flanged and of a size specified by manufacturer of the control equipment.

Note: Use either paragraph 9 (Model T), 10 (Model RS) or 11 (Model TRS) as required.

9. Each control valve shall be electrically connected to one, two or more approved indoor thermostats located at various suitable points throughout the zone under control, so connected that the resultant control is the equivalent of a single thermostat actuated by the average of the temperatures at the various thermostat locations. The thermostatic control instruments shall operate on the resistance thermometer principle. They shall be located where recommended by the manufacturer of the control system, and approved by the Architect.

At the central control operating station located as designated by the Architect and/or Engineer an electrical control panel shall be furnished and suitably mounted for—(A) Automatic control of the steam supply by room thermostats; (B) Manually decreasing the temperature to be maintained at the thermostats at night; (C) Manually increasing or decreasing the temperature to be maintained at the thermostats (Day or Night); (D) Manually positioning the control valve at any per cent of its maximum opening; (E) Indicating the temperature at thermostat locations; (F) Indicating the per cent of control valve opening; (G) Indicating by pilot lights when the control valve is opening or closing; (H) Opening or closing the control valve for emergency.

10. Each control valve shall be electrically connected to an approved thermostat which is to be located on the inner surface of a window glass and to an approved heat-rate thermostat which shall consist of a control radiator equipped with temperature coils above and below the heating element. It shall not be used as heating surface but only as a measure of the heat output of the system. The thermostatic control instruments shall operate on the resistance thermometer principle. They shall be located where recommended by the manufacturer of the control equipment, and approved by the Architect.

At the central control operating station located as designated by the Architect and/or Engineer an electrical control panel shall be furnished and suitably mounted for—(A) Automatic control of the steam supply as measured by the heat-rate thermostat and demands as measured by the window thermostat; (B) Manually decreasing the heat output for night operation; (C) Manually increasing or decreasing in variable amounts the quantity of steam to the radiators as required by abnormal conditions or for rapid heating up; (D) Manually positioning the control valve at any per cent of its maximum opening; (E) Manually controlling the heat output of the system at any per cent of its maximum capacity; (F) Indicating the actual heat output of the system in per cent of its maximum capacity; (G) Indicating the valve opening in per cent of its maximum opening; (H) Indicating by pilot lights when the control valve is opening or closing; (I) Opening or closing of the control valve in emergency.

11. Each control valve shall be electrically connected to one, two or more approved indoor thermostats, one approved thermostat to be mounted on the inside surface of a window glass and one approved heat-rate thermostat which shall consist of a control radiator equipped with temperature coils above and below the heating element. It shall not be used as heating surface but only as a measure of the heat output of the system. The indoor thermostats are to be located at various suitable points throughout the zone under control, so connected that the resultant control is the equivalent of a single thermostat actuated by the average of the temperatures at the various thermostat locations. The thermostatic control instruments shall operate on the resistance thermometer principle. They shall be located where recommended by the manufacturer of the control system, and approved by the Architect.

At the central control operating station located as designated by the Architect and/or Engineer an electrical control panel shall be furnished and suitably mounted for—(A) Automatic control of the steam supply by the indoor thermostats with continued checking of the actual heat output as measured by the heat-rate thermostat and limiting it to the maximum or minimum demand as measured by the window thermostat; (B) Manually decreasing the temperature to be maintained at the room thermostat locations at night; (C) Manually increasing or decreasing the temperature to be maintained at the thermostat locations (Day or Night); (D) Manually positioning the control valve at any per cent of its maximum opening; (E) Manually controlling the heat output of the heating system at any per cent of its maximum capacity; (F) Indicating the temperature at the thermostat locations; (G) Indicating the actual heat output of the system in per cent of its maximum capacity; (H) Indicating the control valve opening in per cent of its maximum opening; (I) Indicating by pilot lights when the control valve is opening or closing and when the control circuit checks the room temperature, the maximum and minimum heat output; (J) Opening and closing the control valve in emergency.

12. The Contractor is to supply a complete Sub-Atmospheric Heating System, including electric wiring, as well as all fuses and switches and electrical connections to power sources where required, all in accordance with manufacturer's instructions, these specifications and local regulations. The power supply for all equipment shall be furnished by extending separate circuits to nearest house panel. All wiring carrying less than 30 volts shall be enclosed in cable and each conductor shall consist of No. 18 gauge solid tinned annealed copper wire covered with not less than .012 in. concentric wall of homogenous rubber and a cotton braid, saturated in wax and color coded, individual conductors twisted together and then an overall braid of brown cotton and saturated in wax. Splices in control cable will not be permitted. All wires in cables shall be connected to terminals on racks in cabinets and soldered thereto. All circuits shall be tested and any found faulty are to be replaced or repaired by the Contractor.

13. VACUUM PUMP. Furnish and install on a suitable foundation where shown on the drawings a Vacuum Pump with accumulator tank equipped with float switch. The pump shall have a capacity to handle the maximum load requirements under operating conditions of 20 pounds discharge pressure at the pump.

26 – 36

The suction of pump to be connected to accumulator tank outlet and discharge of pump connected to boiler (or other apparatus) as directed by the Architect and/or Engineer.

The Unit shall be of the assembled type with pump, air exhauster capable of exhausting air up to 25 inches of vacuum without the addition of cooling water, motor, copper-bearing steel float controlled accumulator tank, air separating tank with float, suction strainer, gauge water level gauge and discharge valve, complete with automatic and manual control.

Automatic and manual control shall consist of a controller with duplex switches capable of governing Vacuum Pump operation to maintain a pressure differential between the steam and return piping with vacuum at variable amounts up to 25 inches and with adjustable means for stopping pump at any lesser vacuum, each pump with on and off switches, seamless bronze float, with adjustable float switch controlling the magnetic type automatic starter and with line switch. All electrical equipment shall be enclosed, wired in metal conduit and mounted on the unit by the pump manufacturer.

The pump shall be of the enclosed impeller type, fitted with bronze internal parts, equipped with approved ball bearings and non-corrosive metal shaft, driven by an approved motor of ample horsepower to handle the load requirements and rotating at not more than 1800 r.p.m. Motors shall be wound for the current characteristics available at the project.

The pump shall have a capacity to handle the rated load in square feet of equivalent direct radiation surface under operating conditions within the radiators of 2 or more pounds per square inch gauge pressure to 25 inches of vacuum.

The Vacuum Pump equipment is to be assembled and valved in accordance with manufacturer's drawings.

Return mains shall be connected to the accumulator tank as shown in detail furnished by manufacturer. Lift connections must not be used except between pump and accumulator tank. There must be gravity flow of water and air from all drip and radiator traps and drip points to the accumulator tank.

14. **RADIATION.** Furnish and install concealed radiators (or cast iron direct radiators) of type and size shown on plans.

15. **RADIATOR VALVES.** Each radiator shall be provided with an externally adjustable or internally fixed orifice valve constructed of red-brass composition of the highest grade, rough body, finished trimming, nickel plated all over with ball-joint unions. Valves shall have non-rising stem plastic bonnet handle and multiport valve sleeves. The valve handles shall be constructed of molded plastic composition, and the metal spindle shall be secured with set screw or equivalent, countersunk. Radiator valves shall be "bellows" type, using a series of bronze diaphragms or a bronze bellows arranged to form a metal wall between the inside and outside of valve.

16. Each concealed radiator shall be equipped with an Adjustable Regulating Fitting, or with a Packless Valve and a Regulating Plate in accordance with manufacturer's instructions.

17. All adjustable valves and fittings to be adjusted and regulating plates installed by the Contractor according to manufacturer's instructions after the heating system has been cleaned.

18. **RADIATOR TRAPS.** Each radiator shall be provided at its return outlet with a Thermostatic Radiator Trap of suitable size for satisfactory operation. The outlet of these traps to be connected to the return piping and to be capable of operating efficiently over a range of steam temperatures and pressures of 15 pounds per square inch to 25 inches of vacuum.

Thermostatic traps (½ in. or ¾ in. size) must have cast brass body with ball joint integral union and be of the angle or offset corner pattern, as is shown on plans or specified. Traps are to have finished trimmings and are to be nickel plated.

19. The thermostatic element is to be of the hollow diaphragm construction made of non-corrosive metal and containing a volatile liquid; said diaphragm to be attached to cover and held firmly and definitely in a fixed position so as to be positive in action and free from noise. Thermostatic traps must be nonadjustable and without bypass and must have been tested and adjusted at the factory under working conditions.

20. **FLOAT AND THERMOSTATIC TRAPS.** Float and Thermostatic Traps capable of operating efficiently over a range of steam temperatures and pressures of 15 pounds per square inch to 25 inches of vacuum shall be furnished for all drips on piping and apparatus connected to the vacuum return lines where the maximum load of condensate exceeds 50 pounds per hour.

21. **PIPE AND FITTINGS.** Furnish and erect a system of steam supply and return piping. All piping to have tight connections, be properly supported and graded to insure free and noiseless circulation. Use wrought steel pipe (or wrought iron) and cast iron fittings of standard weight and quality. The ends of all pipes shall be reamed or filed. Use graphite and oil applied to male threads only for making up all pipe joints. Provide for expansion of mains and risers by using loop type expansion joints and swing connections wherever possible. In other cases provide approved all-metal packless expansion joints.

22. All steam tappings in boiler shall be connected full size of tapping into a steam header which shall be dripped to the return header through a bleeder. Springpieces to steam and return mains shall be taken off the top of mains at 45 degrees. On down-feed systems take the springpieces from the bottom of overhead steam main at 90 degrees.

23. The end of each steam main, down-feed riser and drip point shall be drained into return main using a gate valve, strainer and trap as indicated on plans. Each drip shall flow by gravity into the return main. No lift connection shall be used.

24. Grade steam mains, return mains and drip piping ½ in. in 10 ft., down with flow. All steam supply springpieces, offsets in steam risers and runouts to radiators which grade in a direction opposite to steam flow shall in each case be installed not less than one size larger than the vertical pipe to which they connect and graded ½ in. per ft. Grade return springpieces ½ in. per ft.

25. Risers are to be run concealed or in the open as directed by the Architect. All concealed piping must be tested and made tight at 15 pounds water pressure before being concealed and covered.

26. All union connections, flanges, packing nuts on gate and globe valves and on gauge glass of boiler must be drawn up tight to prevent air leakage into system when under a vacuum. This work must be performed after system is completed and while it is working with a vacuum in both steam and return lines.

27. **FLOOR PLATES, SLEEVES.** Furnish approved floor and ceiling plates and sleeves on pipes passing through floors and partitions.

28. **VALVES AND CHECK VALVES.** All shut-off valves in steam and return piping (except radiator inlet valves) shall be gate valves of approved make. Valves 2 in. and under shall be brass; 2½ in. and larger to be iron bodies, brass trimmed; 5 in. and larger shall be flanged. Check valves shall be horizontal or angle swing type of approved make and with light weight brass disc, tested for tightness. Check valves shall be installed where shown on plans or details, and wherever necessary.

29. **PAINTING.** All exposed piping, and parts of boiler and radiators shall be painted as directed by the Architect. The paint must be applied when the entire system is under vacuum.

30. **COVERING.** Cover all steam mains and their springpieces with 4-ply, 1-in. thick asbestos sectional covering secured in place with metal bands. Fittings to be covered with asbestos cement. Cover all steam and return risers and other piping run concealed in outside walls or concealed in partition within 18 inches of outside wall, with 2-ply ½-in. thick asbestos sectional covering. Cover boiler as specified by boiler manufacturer.

31. **FINISHING UP.** After operating several hours thoroughly blow down and clean out the System under 5 lb. steam pressure, wasting condensate to sewer. After this, close valve in steam main and surface, blow off the boiler through safety valve tapping at 5 lb. pressure, supplying make up water constantly, for at least two hours. Then, extinguish the fire, entirely drain the boiler and allow it to cool before filling with fresh water.

32. **TEST.** When System is finished and cleaned, but prior to covering of pipes, it shall be tested for tightness by the Contractor who shall furnish labor and materials for performing the following test: Obtain a vacuum of 15 inches on a cold* system by operating the vacuum pump. Stop the pump. After two hours, there shall remain 10 inches vacuum on the system.

**System considered cold 5 hours after steam was last on system.*

33. **GUARANTEE.** The Heating Contractor shall guarantee the apparatus installed to circulate steam through every radiator without noise, with a vacuum of 15 inches in steam main. If the installation shall fail to accomplish this guarantee by reason of any defect developing within the first heating season due to faulty material or workmanship, the Contractor shall remedy such defect at his expense within reasonable time after notice.

34. **FINALLY.** Nothing herein contained shall be construed to relieve the Contractor from making good and perfect work in all details of construction.

THE DUNHAM *Temperator*

A COMPACT, EFFICIENT AND ATTRACTIVE UNIT FOR HEATING AND COOLING

An All Purpose Conditioning Unit

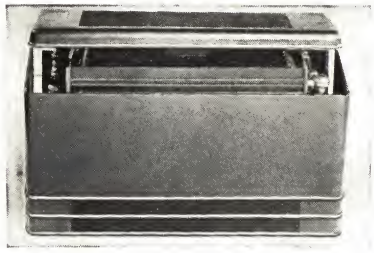
For the home, the store or the office, or wherever healthful temperatures are desired or important, this Dunham Temperator is a logical solution.

Whether for winter or summer service, or for both, the Temperator may be installed with access to outside atmosphere. A uniquely designed damper, operating on ball bearings and subject to either automatic or hand operation, regulates the amount of outside and inside air to be mixed and circulated. Coincidental with the tempering of the air is the humidifying element, which, by increasing or decreasing moisture content in the delivered air, insures healthful humidity. A distinctive feature of Temperator is its adaptability to all Air Conditioning requirements.

EASY AND FULL ACCESS TO ALL PARTS

The Temperator for Winter Service

The fundamental basis of winter air conditioning is good heating. For this reason Temperator has been created as a part of the Dunham Sub-Atmospheric Steam Heating System, because this system, by reason of the great range of "cooler" steam temperatures on which it operates in mild weathers, simplifies humidifying problems. But whether used with Sub-Atmospheric Heating or with less modern systems circulating pressure steam or hot water, the unit will in all cases provide clean, properly warmed and correctly humidified air with a comfortably exhilarating yet quiet air movement.



Top is held by concealed catches

The Temperator for Summer Service

In the summer time, instead of adding heat and humidity as in the winter time, it dehumidifies and cools. The other functions of cleaning and giving air motion as well as supplying a steady stream of fresh air remain the same, and regulating adjustments are available to meet any and all conditions. A special feature lies in the heating and cooling coil which is three times greater area in cooling surface than when used for heating, yet utilizing the same supply and return connections. The change from heating to cooling is made by switching the system from contact with a boiler to a connection with a chilled water supply or a refrigerating unit which may be at a remote point. Three fan speeds add to the adjustment for heating and cooling a given space.

The unit may be adjusted to circulate outside air, a mixture of outside air and inside air, or it may be confined to the recirculation of the inside air alone. This is all accomplished by the adjustable damper. Through regulation of the operation valve and electric switch, it is possible to adjust the temperature of the air to suit the individual preference.

Side cover provides access to valve and damper adjustment lever

Construction Features

The heating and cooling element is constructed entirely of non-corrosive materials.

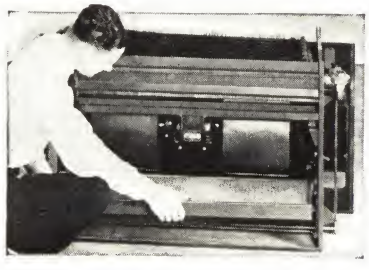
The tubes and fins are of copper and all castings are of bronze. The entire heating and cooling element design is such as will present a minimum restriction to the flow of air and permits a minimum transfer of heat. As a final guarantee of permanence in service, each element is tested hydrostatically to a pressure of 175 pounds per square inch.

The unit is designed to coincide with the modern motif of interior decoration. Its smooth flowing lines, finished in metallescent brown, are set off with a restrained use of stainless steel. No mechanism or operating controls are visible, yet are easily accessible.

Top right hand cover conceals motor switch

Installation Service

Wherever the Temperator is to be installed, a Dunham trained Engineer will cooperate with you in designing and supervising its installation.



Sides may be tilted out and off for access to water, pans and filter

THE DUNHAM
Sav-T-Heat SYSTEM USING GAS FUEL

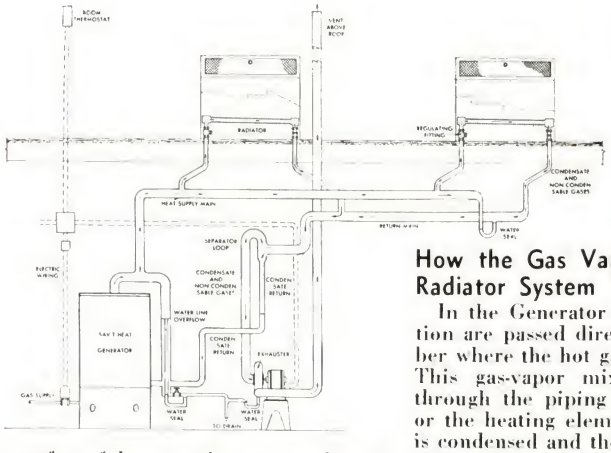
A Practical, Efficient and Economical Method of Residential Heating and Air Conditioning

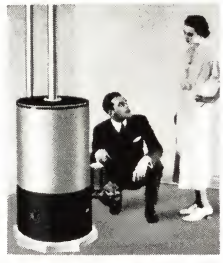
Sav-T-heat is not just another boiler or furnace. It is a heat generator. In effect, it becomes a heat distributor extracting heat from gas fuel so efficiently and economically that gas heating is no longer a luxury. The system harnesses the products of combustion and *makes unnecessary the need for the large chimney.* It can now be replaced by a small copper vent pipe or flue.

Sav-T-heat utilizes an entirely new principle of heat transfer to obtain high efficiency with little heat waste; it also eliminates costly chimney deterioration which sets limits on the practical efficiencies obtainable from traditional heating plants. This system adds vapor to the products of combustion (after combustion is completed) at a rate which keeps the condensate at sufficiently harmless dilutions at all times, and provides moisture which flushes the entire system continuously of impurities when it is in use.

Sav-T-heat may be installed as an air conditioning system, as a vapor radiator system, as a hot water system or a combination of these. The same high efficiencies are obtainable with each type of system.

Time and laboratory tested. Laboratory test procedure is important in making efficiency and other tests, but actual seasonal operating conditions must be duplicated as far as possible. Sav-T-heat has not only been tested by many laboratories where efficiency up to 97% have been found, but has been in use for a number of heating seasons actually heating a great many homes with long time efficiencies commonly found in the 90% range.





How the Gas Vapor Sav-T-heat Radiator System Functions

In the Generator the products of combustion are passed directly into a mixing chamber where the hot gases take up water vapor. This gas-vapor mixture is then conveyed through the piping system to the radiators, or the heating elements, where the moisture is condensed and the gases are cooled by the transfer of heat to the surrounding air. The condensate and the cooled gases then pass into the return piping. The condensate is returned to the water jacket of the Sav-T-heat Generator and the non-condensable gases pass to the exhauster which discharges them through a flue to the outside. The circulation in a complete system is shown on the schematic diagram. The exhauster "draws" upon the Generator through the system giving this circulation as well as maintaining the draft upon the combustion chamber.

Volume Water Heating with Sav-T-heat. See detail ⟶

This hot water type Sav-T-heat Unit is ideally suited to large volume water heating for apartment buildings of medium size as well as medium size office buildings.

Under constant operation it is possible to obtain 100 Gal. of water per hour average—with 100° rise in temperature delivered to the storage tanks with typical Unit efficiencies in the 90% range.

The Sav-T-heat Unit may be connected in parallel with other hot water heating means. Where extra capacity is required above that of one generator, additional Sav-T-heat Units may be connected in parallel to care for such loads.

Conversion Type Sav-T-heat for Use on Hot Water Heating System

The Hot Water Type Save-T-heat Unit as constructed may be used on changeover existing low temperature hot water home heating systems.

The Hot Water Type Sav-T-heat Unit consists of a standard Sav-T-heat generator and exhauster with a twin coil heat exchanger mounted on top of the generator surrounded by a jacket of the same width as the generator—making a unit standing on the floor approximately six feet high and eighteen inches diameter.

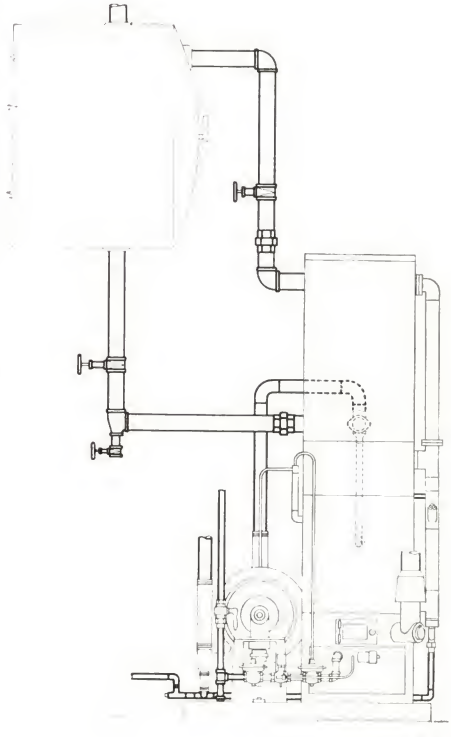
The unit is highly efficient because it is well insulated and has controlled combustion. There is no draft over the water heating surfaces when the gas burner is off. Natural chimney draft cools other types of heating units and thus waste heat up the chimney. Excessive up-draft or down-draft does not affect Sav-T-heat through this small 2 in. vent pipe.

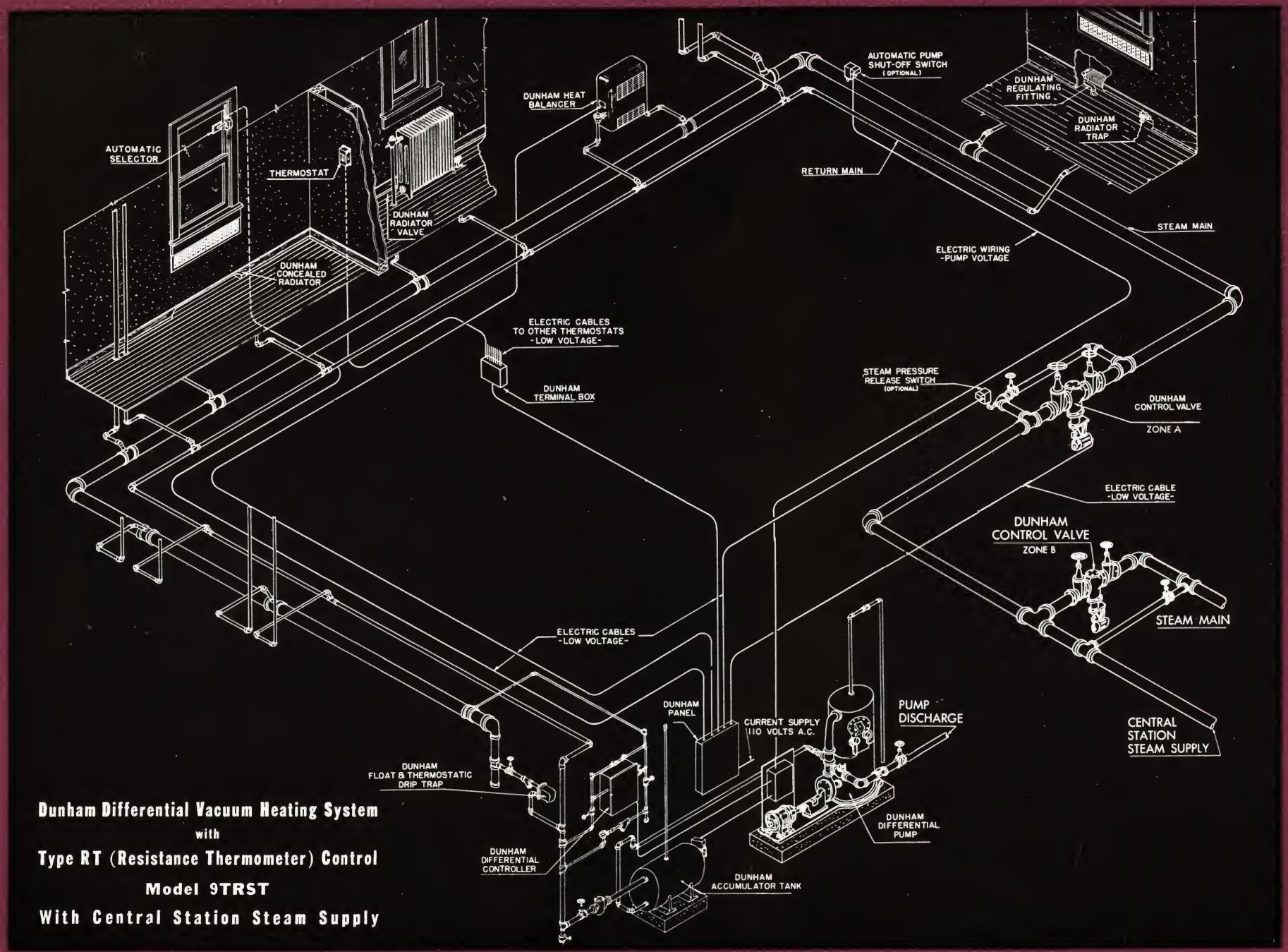
Sav-T-heat as a Comfort Conditioning System

The Sav-T-heat System provides winter and summer air conditioning. It makes available to the home the comfort of air conditioning found in commercial installations such as theaters, office and public buildings.

In winter service Sav-T-heat Conditioners clean the air, heat it to a comfort level, humidify it (that is, charge it with the proper degree of moisture content), and deliver it evenly and consistently with the greatest economy.

In summer service the air conditioner can be used to ventilate the home. At night the cooler outside air can be drawn in through the filters, and circulated clean and cool, through the rooms. In the day time cool air from the basement can be circulated. Additionally, chilled water may be circulated through the coil (used for heating in winter service) providing cool and dehumidified air. A simple means converts the copper heating coil into a cooling coil.




AUTOMATIC SELECTOR
THERMOSTAT
DUNHAM RADIATOR VALVE
DUNHAM CONCEALED RADIATOR
DUNHAM HEAT BALANCER
AUTOMATIC PUMP SHUT-OFF SWITCH (OPTIONAL)
DUNHAM REGULATING FITTING
DUNHAM RADIATOR TRAP
RETURN MAIN
STEAM MAIN
ELECTRIC WIRING -PUMP VOLTAGE
ELECTRIC CABLES TO OTHER THERMOSTATS -LOW VOLTAGE-
DUNHAM TERMINAL BOX
STEAM PRESSURE RELEASE SWITCH (OPTIONAL)
DUNHAM CONTROL VALVE
ZONE A
ELECTRIC CABLE -LOW VOLTAGE-
DUNHAM CONTROL VALVE
ZONE B
STEAM MAIN
ELECTRIC CABLES -LOW VOLTAGE-
DUNHAM PANEL
CURRENT SUPPLY 110 VOLTS A.C.
PUMP DISCHARGE
CENTRAL STATION STEAM SUPPLY
DUNHAM FLOAT & THERMOSTATIC DRIP TRAP
DUNHAM DIFFERENTIAL PUMP
DUNHAM DIFFERENTIAL CONTROLLER
DUNHAM ACCUMULATOR TANK
Dunham Differential Vacuum Heating System
with
Type RT (Resistance Thermometer) Control
Model 9TRST
With Central Station Steam Supply